

Metro Futures: Experience-Centred Co-Design at Scale

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ABSTRACT

This paper discusses how characteristics of experience-centred and collaborative design can be translated to larger scales. We describe *Metro Futures*, a region-wide public consultation on the design of new light rail trains, where we followed an experience-centred co-design approach supported by digital media and tools to develop findings with a core group of 20 ‘co-researchers’ and ~4000 public participants. The paper discusses how the characteristics of a focus on experience, and collaborative design exploration were achieved with co-researchers and, at scale, through online and face-to-face interactions using various digital media and tools. Whilst not at the depth of smaller scales, there are opportunities to retain characteristics of experience-centred co-design at scale to produce findings that can usefully inform ensuing design work, and avoid the averaging of public contributions often evident in large scale public consultations.

Author Keywords

Experience-centred design; co-design; large-scale design; public transport.

CSS Concepts

• Human-centered computing~Human computer interaction (HCI); Empirical studies in HCI

INTRODUCTION

In embracing participatory design [20,33], human computer interaction (HCI) has long recognised the importance of giving those likely to be affected by digital systems a voice in their design. Similarly, HCI’s turn to experience [22] recognises the value of understanding everyday experiences of technology as a resource for design. As concepts such as Smart Cities [3,4] and Digital Civics [5,26,39] gain traction in HCI, we ask how experience-centred and collaborative design approaches are translated to larger scales to inform the design of urban environments, public services, and the digital systems embedded in them. And, of particular

relevance to HCI, how might interactive digital technology support experience-centred co-design at scale.

Understanding how to undertake experience-centred and collaborative design is well established at the scale of small-to-medium participant groups and individual systems or services. Less well understood is the extent to which attention to everyday experience and the collaborative exploration of design proposals can be maintained at larger scales of more numerous and distributed participants. Our research group was able to investigate experience-centred co-design at scale through work with Nexus, a publicly-funded organisation who plan, provide, and promote public transport services for the Tyne and Wear region in the UK including the Tyne and Wear Metro (henceforth Metro), the busiest urban light rail network outside of London.

Metro Futures was Nexus’ programme of public consultation on the design of new trains for Metro. Although the network has been extended and improved since its launch in 1980, the original train fleet is still running and is reaching the end of its intended 40-year working life as the availability of replacement parts diminishes. In 2016, Nexus thus approached the UK Government for funds for a new train fleet. *Metro Futures* was intended to support this application through demonstrating Nexus’ attention to their passengers’ requirements for new trains, which would then be passed on to the companies competing for the manufacturing contract.

When Nexus approached us, the plan for *Metro Futures* consisted of traditional public consultation activities: a postal and online questionnaire conducted by Nexus and, interviews and focus groups conducted by UK independent passenger watchdog Transport Focus. Aware of our research group’s track record in experience-centred and collaborative design, Nexus began discussions with us regarding a third strand that would draw upon our work to complement the two existing consultation strands in three ways. The third strand would: (i) have a more open remit where consultation topics would be developed from public participants’ experiences of using or attempting to use Metro trains rather than being prescribed in advance (as they were in the other two strands); (ii) explore desirable futures for Metro trains in addition to current concerns; and, (iii) use digital media and tools, and creative activities to enable region-wide public conversations about the future Metro.

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This paper contributes our practical lessons learned in *Metro Futures* as an investigation of digital media and tools, and activities for experience-centred co-design at scale in the early specification and idea generation phases of a longer-term design process, such as that involved in replacing public transport infrastructure. In particular, how strategies such as beginning with, sharing, and making sense of experience, and encouraging a move from current ‘problems’ to collaborative generation and exploration of design proposals, can usefully translate to activities at larger, regional scales.

We describe our strand of *Metro Futures* as a case study of experience-centred co-design at scale, at three levels: (i) the study design, including the structure and rationale for the experience-centred co-design process used; (ii) an account of the design process and its findings; and, (iii) a description of the value of our strand findings as distinct from the Nexus and Transport Focus strands. From this we discuss the effectiveness of our approach before discussing implications for experience-centred co-design at scale. We begin the paper with a review of related work that informs the experience-centred co-design approach we sought to apply.

BACKGROUND

Experience-Centred Co-Design

The turn to experience in HCI, design, and public service improvement [1,22,41,42] involves a commitment to understand the quality of people’s everyday experiences of what is being designed in order to improve such experiences. In HCI, for example, design-oriented research has developed pragmatic conceptualisations of technology in terms of experience [23,41]; a framework for designing experience [16,17]; and, attention to how experiences can be created and shared with others [2]. In public service improvement, experience-based co-design (EBCD) is a health service improvement method combining aspects of practitioner action research and collaborative design, which was developed by the UK National Health Service’s, then, Institute for Innovation and Improvement [1,13,18].

Experience-centred and collaborative approaches to technology design highlight the importance of design participants (users and technology designers) understanding their experiences together, as a process of mutual learning [29], where participants make their experiences sensible to one another to enable constructive dialogue [24]. For example, in EBCD this is enabled through recording and sharing individual’s stories of using or working in a health service, and using physical tools such as emotional maps to collectively make sense of multiple individuals’ experiences.

Attention to everyday experiences and collective sense-making provide a firm foundation for a design process. However, there is a need to move design work from the consideration of current ‘problems’ to the exploration of future possibilities. Collaborative creative activities [30] and designerly strategies such as reframing accepted problems and exploring the relevance and impact of potential designs

through making [8,14,32] offer the means of making such a move through generating and exploring design proposals.

Experience-centred co-design is the term we adopt in this paper to encompass the facets above, and to characterise the design approach we employed in our strand of *Metro Futures*. Such experience-centred co-design then provided an opportunity for Nexus to engage with their Metro passengers in a different manner than they were accustomed to through surveys, structured interviews, and focus groups. Namely to engage with Metro passengers’ experiences, and to consider passengers as generators of design proposals as well as sources of design requirements.

Our experience-centred co-design approach then comprised of commitments to: start the process with participants’ everyday experiences of Metro; enable participants to make sense of their experiences with each other and with designers; and, move participants from considering concerns or problems to developing and exploring alternative design proposals. Our research investigates how these commitments can be translated to larger numbers of participants not necessarily co-located or co-present in design workshops.

Co-Designing at Larger Scales

Collaborative design already happens at scales larger than individual systems or services and/or with distributed and diverse participants. Open Design and its associated web tools [9,11] supports co-design by distributed participants, however Open Design relies upon individuals having the motivation and the technical means to take part. At city and neighbourhood scales of public deliberation, various HCI research projects have investigated how people can be engaged in public concerns and then express their views through the deployment of interactive systems in public places, including tangible voting devices [19,36], responsive public displays [34,37], and interactive posters [38]. These studies highlight that simple interaction mechanisms and modalities invite engagement and lower barriers to participation; public interactions with technology prompt further engagement through social interaction; and, placement in public locations where people spend time (e.g. bus stations) encourages participation. This work also cautions that engagement with interactive systems does not necessarily equate to meaningful debate, expressing personal opinions can create tensions between privacy and transparency, and participants can be sceptical of whether their engagement with such systems will lead to action [35].

The Digital Civics agenda [5,27,39] also implies a need to engage people in design and research at larger scales such as public services, local democracy, and community action. As with Open Design, digital media and technology can support participation, e.g. through collaborative design games on WhatsApp [21]. Projects such as Let’s Talk Parks [7] highlight a need to support participation in public service transformation through socio-technical means, integrating face-to-face and creative activities with technological tools.

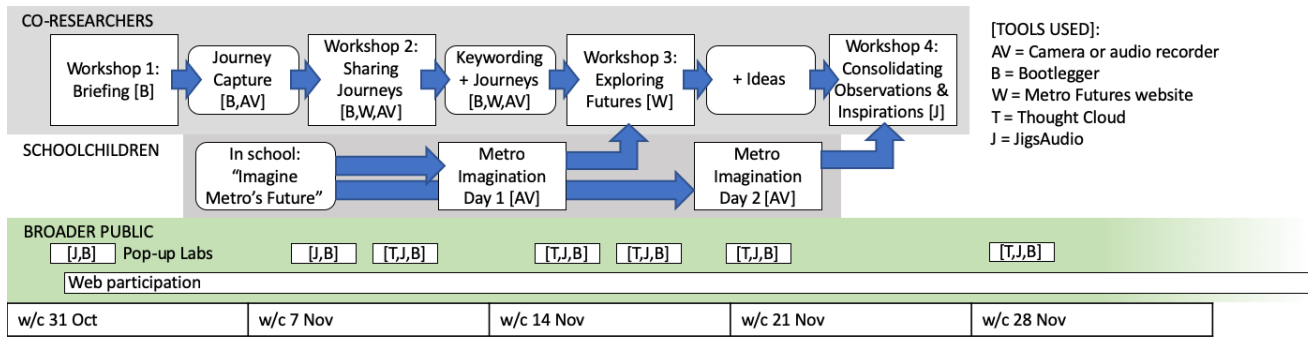


Figure 1. Our Experience-Centred Co-Design process for *Metro Futures*

Dalsgaard discusses how values and methods from Participatory Design be embedded in larger scale projects [10]. Reflecting on the Mediaspace project to redesign a municipal library, he describes the challenge of considering heterogeneous and changing user needs, particularly where the object of design is undergoing transformation (e.g. libraries becoming more than information repositories). In Mediaspace, this challenge was addressed through a variety of activities – from more structured and time-constrained activities (workshops, ‘town hall’ meetings) to more informal and serendipitous activities (exhibitions, drop-in ‘Labs’) – supported by technology that both inspired and scaffolded participation. Crucially, Dalsgaard highlights how activities informed each other in a non-reductive manner, where activity-specific findings were made accessible to participants as stimulations for ongoing dialogue, and were made manifest in other activities.

Our paper seeks to build upon and complement all of the above work. Where Dalsgaard’s paper [10] emphasises establishing participation as a relevant activity for public and library design participants (reflecting values from Participatory Design [33]), we consider how an experiential focus and the collaborative generation and exploration of design proposals can be retained at larger scales, and in projects extending over months rather than years.

METRO FUTURES: STUDY DESIGN

Our experience-centred co-design strand of *Metro Futures* largely took place in November 2016, following the strands undertaken by Nexus and Transport Focus. We configured our strand to investigate undertaking experience-centred co-design at scale. We describe our insights from this study in the account of our design work and design findings given in the ‘Metro Futures: Design Process and Findings’ and ‘Metro Futures: Value of Design Findings’ sections.

Objectives

Prior to November, we worked with Nexus to agree the objectives for our strand to take account of Nexus’ requirements for *Metro Futures*, the research objectives for the programme funding our involvement, and our research interests in experience-centred co-design. The resulting research plan included Nexus’ requirements to consider the needs of both commuters and leisure passengers, and those

travelling with or using wheelchairs, pushchairs, and mobility scooters.

During planning, Nexus frequently mentioned topics of particular interest to them for the public consultation, which related to specific physical aspects of the inside of trains, including seating layouts, and the material and finish of seating. Nexus were also explicit that the consultation should only consider internal design features of the new trains. In response, and recognising that the Nexus and Transport Focus strands already included specific questions on these topics, we agreed with Nexus that our experience-centred co-design strand would instead begin with- and develop from- participants’ experiences of the Metro, rather than having these topics imposed upon it. Nexus’ particular topics of interest would then be revisited in reporting our findings.

A Process for Experience-centred Co-Design at Scale

Our process for experience-centred co-design at scale, and the activities within it, was devised in general terms in advance but was also adapted and refined as the project progressed. We describe these responsive adaptations in our account of the unfolding project. At this point we describe the overall shape of our process, and its rationale.

In devising our design process, we were concerned that an experience-centred co-design process at the scales typically used in HCI and design research would not engage as many people across the region as the Nexus and Transport Focus activities. Simply involving more people in typical experience-centred co-design activities would create major practical difficulties, e.g. managing the logistics of larger and multiple workshops, facilitating experience-sharing within and across larger or multiple groups. So, our challenge was to work out how experience-centred co-design activities could both inform and be informed by different larger-scale public activities. Furthermore, there was an opportunity to explore how such larger-scale activities could go beyond confirming the insights of a smaller group to enable a bigger design conversation about future Metro trains.

We therefore devised a process consisting of a sequence of activities for a small core group participating throughout the project in parallel with and mutually informing a series of events to engage larger numbers of people in shorter, individual conversations. We referred to our core group of

participants as ‘co-researchers’ because our activities were devised to engage them as collaborators in our research into the experience-centred requirements and design proposals for new Metro trains. Our process then consisted of four weekly design workshops with our co-researchers (with intervening activities they undertook independently) whose insights and ideas would be shared and developed with larger numbers of people through a series of seven ‘Pop-up Lab’ public drop-in sessions and a *Metro Futures* website – see Figure 1. The process also approximately followed two phases of divergent-convergent activity exploring current concerns and then future possibilities for Tyne and Wear Metro, akin to the UK Design Council’s Double Diamond model of design [6]. Consequently, the four design workshops and intervening activities were structured around: recording and sharing experience; making sense of experience and identifying concerns; exploring future possibilities; and, consolidating concerns and ideas.

Pop-up Labs were intended as drop-in sessions in busy public places where passers-by would be prompted to contribute their own concerns and ideas and, as the project progressed, respond to concerns and ideas raised by the co-researchers. The project website also enabled online visitors to respond to concerns, ideas, and any previous responses.

An associated activity for local schoolchildren was devised to develop novel design proposals, as an input to the third co-researcher design workshop, to extend exploration of design possibilities beyond experience-based proposals alone.

Study activities were coordinated by the first author, with task facilitation (workshop subgroup activities, Pop-up Labs, Schools activity etc.) shared between 14 research group colleagues with HCI and/or design experience (including all the authors), with two to four facilitators per task.

Recruitment

During the planning stages, Nexus stipulated that our participants should be representative of the whole of Tyne and Wear rather than its main city of Newcastle upon Tyne. This was to avoid criticisms often directed at previous public consultations as being Newcastle-focussed. We ensured such region-wide representation in recruiting co-researchers and in selecting venues for the design workshops and Pop-up Labs.

Twenty co-researchers were recruited via advertisements in the region’s free newspaper, Nexus’ email newsletter, relevant social media, and leaflets in local libraries and public transport information shops. To enable us to ensure participants with the relevant experiences and the regional spread requested by Nexus, application forms asked applicants for their age, home address, type and frequency of their Metro journeys, and use or desired use of wheelchairs, pushchairs, and bicycles. Applicants were also asked to agree to attend four evening workshops throughout November.

Due to limited places, the co-researcher application process was competitive. Co-researchers were not selected to be

representative of gender, ethnicity, or ability. Rather our recruitment rationale focussed on bringing a core group of motivated participants with diverse perspectives together into productive dialogue to generate representative discussions at scale, recognising that diverse and (possibly) extreme experiences can usefully highlight additional issues [12]. Furthermore, we needed co-researchers to become engaged collaborators not simply informants, and our recruitment process meant that applicants brought concerns and motivations around Metro and public transport as enthusiasts and/or as those experiencing difficulties. The resulting co-researcher group included participants with a broad age range (16-70, mean 42.5), unequal gender split (5 female, 15 male), and all white ethnicity. Several participants had disabilities (three visually impaired, one hearing impaired), and the group also did not include any wheelchair users, although one participant had relevant experience through accompanying her daughter in a wheelchair.

Digital Media and Tools

Our participants recorded digital media and used several digital tools within our experience-centred co-design activities (also noted in Figure 1). Some were pre-existing tools, others were adaptations or new developments for the project. Tools were deployed by design team members familiar with them and/or involved in their development. We provide brief summaries of these media and tools here, and describe their use within our experience-centred co-design process in our subsequent account:

- *Bootlegger* [31] enables collaborative recording of videos relating to a particular event or theme. Users commission the quantities and types of clips in advance according to the event or theme, e.g. close-up and wide-angle shots for a music video or particular topics for an instructional video. Clips are then assigned between several users to record via prompts in a mobile app.
- Some participants chose to use their own cameras and audio recorders, or equivalent native apps on personal smartphones and tablet computers to capture media.
- *JigsAudio* [40] elicits combinations of hand-written or drawn and spoken responses to a topic. Users are invited to write/draw responses onto large RFID-tagged jigsaw puzzle pieces and then to record an audio comment/description on a Raspberry Pi -based unit that associates a puzzle piece RFID-tag with the relevant recording.
- *ThoughtCloud* [15] is a tablet computer-based tool for eliciting responses to a set of pre-configured pairs of video plus question/prompt, which encourages users to elaborate their answers using audio or video comments.
- A project website was developed to (at first) promote and share information about our strand of *Metro Futures*, and (during the project) as a tool for co-researchers to share and make sense of their journey recordings (in password-restricted sections of the site), and for sharing findings with and eliciting feedback from the broader public. Material collected through the previously described tools was shared in this way.

Documenting and Analysing the Design Process

Documenting our accounts of- and reflections upon- the co-design process for the purpose of research proved challenging. This was particularly so when we were primarily occupied with coordinating the numerous labour-intensive project activities. However, several sources of data enabled us to subsequently reflect on our activities, and the digital media and tools used:

- A researcher from another research group and not directly involved in *Metro Futures* conducted semi-structured interviews with us twice: in October 2016, to understand our plans, rationales and concerns for our activities; and, in June 2017 to discuss project outcomes and our reflections on the process.
- In December 2016, research group colleagues who had helped facilitate activities met to reflect on the value of the various media and tools used during the project. This discussion was audio-recorded and transcribed.
- The first author compiled a reflective chronological account from meeting records, emails, and material generated during the public engagement activities.
- Google Analytics and other software metrics, such as number and timing of website comments, were used to quantify public interaction with the website.
- And, lastly, the media and text created and shared by co-researchers provides a rich source of qualitative data.

We draw upon all these sources to describe how our various activities, and digital media and tools supported experience-centred co-design at scale.

METRO FUTURES: DESIGN PROCESS AND FINDINGS

In this section we describe our strand of *Metro Futures* and the findings it produced in relation to new Metro trains. Our account is structured according to the aspects of experience-centred co-design and designing at scale we describe earlier. As the co-researcher activities and broader public activities ran in parallel (see Figure 1), the account is approximately chronological as some aspects overlapped in time.

Public participation in our strand of *Metro Futures* was high. Of the 20 co-researchers originally recruited, 17 attended three or more of the four two-hour design workshops, and two new co-researchers joined the last workshop, having impressed us with their enthusiasm at a Pop-up Lab. We estimated that 300 people engaged with us at the seven Pop-up Labs across Tyne and Wear. Six schools participated in the ‘Imagine Metro’s Future’ activity, including 55 school children and their teachers spending a day developing their ideas with us. And over 3500 people visited our *Metro Futures* website during the main period of our activities, and left comments and agree/disagree votes.

Starting with Lived Experiences of Metro

In the first design workshop we explained our intended experience-centred co-design process, and how we would begin with co-researchers’ experiences in relation to Metro journeys. This included demonstrating and practicing with

the *Bootlegger* mobile app that we suggested co-researchers use to record their journey experiences.

We configured *Bootlegger* differently in *Metro Futures* to its typical application. *Bootlegger* allows specific video content to be commissioned from a group of users based on textual prompts, typically shots required for a particular genre of video [31]. In *Metro Futures* we configured these prompts to capture different aspects of participants’ Metro journey experiences. We devised nine open and ambiguous prompts (see Table 1) rather than use any of Nexus’ topics of particular interest. This was to ensure the open remit we had agreed by enabling co-researchers to set the topics for subsequent conversations – through what they recorded – rather than steering these conversations by prompting for recordings relating to Nexus’ topics of interest (e.g. seating layout and type). The prompts were devised following our own earlier experiments recording Metro journeys and were intended to present a range of cues to experience representing both more positive and negative aspects.

Recording Prompt (# Private, Group, Public)	Total
Something that works well (0, 6, 5)	11
Something you would like to change (2,11,10)	23
What you value about the Metro (1, 2, 4)	7
How you feel about your journey (0, 0, 1)	1
Something that makes you feel comfortable (0, 1, 1)	2
Something that makes you feel uncomfortable (0, 3, 4)	7
How noisy or quiet your journey is (1, 2, 3)	6
How busy or calm your journey is (0, 2, 3)	5
Anything else important or interesting (2, 5, 2)	9
Test recordings and uncategorised (0, 6, 0)	6
TOTAL (6, 38, 33)	77

Table 1: Bootlegger Prompts and Numbers Recorded

We were aware that video might not be an appropriate medium for our visually-impaired co-researchers, and it became apparent that another co-researcher did not own or feel competent in using a smartphone. We therefore explored other ways of recording journey experiences with these co-researchers but, crucially, asked them to record using the same set of nine prompts used in *Bootlegger*. Two of the visually-impaired co-researchers chose to undertake Metro journeys whilst accompanied by a friend using *Bootlegger* (one of whom later reverted to using their iPhone’s native camera app and accessibility features), and the third visually-impaired co-researcher chose to use her own audio recorder to capture journeys. We discovered that the co-researcher without a smartphone was a transport enthusiast who routinely used a 35mm film camera to photograph public transport. We therefore encouraged him to take photographs

and bring prints to subsequent workshops, which we would then scan and add to the website for him. In actuality, the co-researcher presented his responses to prompts as ‘photo essays’ – two or more photographs mounted on a sheet of paper with additional written explanations, which we included as descriptions alongside the scanned photographs.

During the November activities co-researchers added 77 *Bootlegger*-captured videos to the website and recorded an additional 14 videos, 6 audio recordings, and 19 photo essays. All of the recordings were used to share experiences at subsequent workshops, and were added to the website (except audio recordings that were not re-formatted in time).

Although “something I’d like to change” had the largest number of clips, our open and ambiguous prompts were effective in encouraging co-researchers to share a diverse range of experiences. Co-researchers made recordings and discussed topics including: claustrophobia on busy trains, enjoying the views from front-facing windows, frustration over the wasted space for redundant drivers’ cabs, difficulties understanding driver announcements, anxieties caused by others’ anti-social behaviour, and noise and climate on trains (see Video Figure).

Making Sense of Metro Experiences

We deliberately avoided strongly prescribing the topics for our design conversation with co-researchers in our use of *Bootlegger* in workshop one, but there was nevertheless a need to identify co-researchers’ main concerns to both consolidate co-researcher findings for sharing on the website and at Pop-up Labs, and to enable progress in the design process overall. A balance was required between enabling progress in the time available and not overly reducing complex and differing participant perspectives. We attempted to balance making progress and maintaining some diversity in perspectives by undertaking the identification of key concerns *with* co-researchers, as active participants.

Our process of identifying key concerns with co-researchers was to collectively make sense of their Metro recordings in workshops and through a private area of the website. At the second workshop, co-researchers were asked to play-back and explain their journey recordings in small groups. Groups then compiled lists of keywords that characterised common and important aspects of their experiences (e.g. seating, luggage, noise), and a combined list of 22 keywords was produced from the group lists. A password-protected area of the website enabled co-researchers to share and view each other’s recordings, and to add descriptions and additional keywords, which a few did. In the third workshop, co-researchers reviewed the full list of keywords and rated each as high, medium, or low importance.

The co-researchers’ keywording and rating activities provided higher-level entry points into their rich data set. As we explained to co-researchers in design workshops, there were practical needs to make sense of and structure their findings such that website and Pop-up Lab visitors could

navigate and understand them during their typically brief visits, and to agree the main topics for subsequent design conversations. Therefore co-researchers’ rich data was not lost, only moved a stage deeper in public interactions.

Scaling-Up Experience Capture and Idea Generation

We attempted to capture Metro experiences in the early Pop-up Labs using *Bootlegger*. However, we found that because it was not possible to record actual live experiences, either a retold experience or an opinion about an experience had to be recorded instead, which was less effective. The nine prompts described earlier were also available, but only as interview prompts and provided less valuable information.

Our *JigsAudio* tool was also on-hand at Pop-up Labs and it became clear that it was more effective than *Bootlegger* at engaging public visitors and encouraging them to share their experiences of and ideas for Metro. For its *Metro Futures* deployment, *JigsAudio* consisted of a set of jigsaw pieces that could be connected in a line to form a line drawing of a Metro train. At Pop-up Labs, a train jigsaw and spare pieces, *JigsAudio* recording device, and a set of coloured pens were laid out on a table top and visitors were invited to draw or write their concerns and ideas onto the train outline and then to record an audio description or comment. The growing set of completed jigsaw pieces was available at subsequent Pop-up Labs for visitors to inspect and respond to (playback of previous audio descriptions was not possible at the time). This presentation provided an intriguing and visually stimulating focus that, along with previously drawn-on pieces, encouraged Pop-up Lab visitors to make contributions. The *JigsAudio* pieces completed at Pop-up Labs (images and associated audio recordings) were added to the project website after the last Pop-up Lab.

Pop-up Lab visitors’ *JigsAudio* contributions largely consisted of requests or ideas for new train features (20 of 24 contributions) rather than comments about the current trains and service (5 of 24 contributions). The majority of visitors used drawings and/or arrows in addition to text to indicate and illustrate their ideas and concerns in relation to features on the Metro train outline. Only six contributions used text alone and several added colour and decoration – Figure 2.

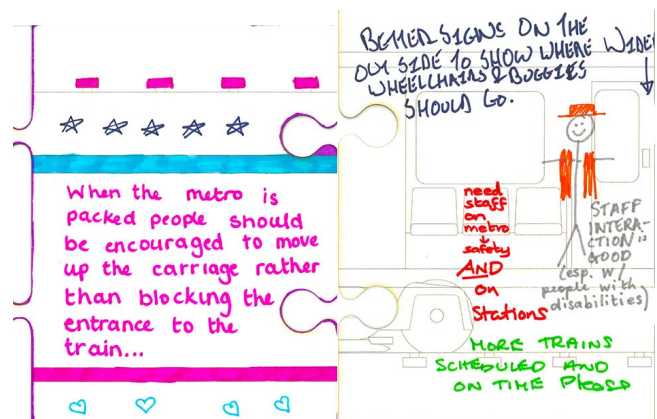


Figure 2. Example *JigsAudio* pieces

Similar to the Metro journey recordings, *JigsAudio* was effective at eliciting concerns and ideas that went beyond Nexus's topics of interest. Comments on the existing service included staff interaction and feeling unsafe late at night. Requests and ideas for new trains were far-ranging including: greater visibility of security cameras; improving the interior environment using softer lighting, colour scheme choice, and classical music; more and clearer signage and information; reduced fares; and, women-only carriages.

Developing and Exploring Alternative Design Proposals

A significant point of difference between our strand of *Metro Futures* and the Nexus and Transport Focus activities was that we would *generate* design proposals for the new Metro trains. The Nexus and Transport Focus surveys, interviews, and focus groups considered design in terms of public preferences for and discussion of *predetermined* design proposals (e.g. on seating layout options). Our strategy was, in part, to develop design proposals from co-researchers' experiences. However, this was more than a process of co-researchers developing ideas in response to their identified concerns, and we introduced new and alternative ideas to encourage co-researchers' exploration of a broader space of possibilities with us.

We devised the 'Imagine Metro's Future' schools activity to encourage children to generate novel design proposals that could stimulate and broaden the design conversation as both future passengers and those likely to respond imaginatively and a less constrained manner. Children's design proposals were then used in subsequent design workshops, Pop-up Labs, and on the website.

Children from six schools aged 9-13 were invited to imagine a Metro journey in 2036 and capture their ideas as stories, drawings, and models. Groups from each of the schools were then invited to participate in one of two 'imagination days' onboard an empty train at a city centre Metro station. During these days, children shared their ideas with each other then worked in teams to make short video advertisements using tablet computers and low-fidelity props to explain their combined ideas. Schoolchildren entered drawings, stories, and models, and produced 15 'TV ads'. All entries were shared on the website.

Developing ideas for the design of new Metro trains was the main activity of the third design workshop, and we used video clips at the beginning of the workshop to stimulate co-researchers' thinking. First, an excerpt from the BBC science and technology television programme 'Tomorrow's World' followed by the schoolchildren's TV Ads. The excerpt, from 1979, described the then forthcoming Tyne and Wear Metro and we used it to remind co-researchers that the Metro was considered innovative at its launch, and to encourage them to explore future innovations. Co-researchers devised 32 ideas in the third workshop.

The workshop ideation activities encouraged co-researchers to connect their ideas to the experiences they had previously

shared and discussed. The keyword rating activity, described earlier, reminded co-researchers of their main concerns and they then developed user stories of the form "As a ____ I would like the new Metrocars to ____ because ____." These user stories then encouraged co-researchers to contextualise their ideas in terms of who could benefit and why.

The third design workshop succeeded in producing user stories grounded in co-researchers' experiences but it was less effective in encouraging exploration of a broader space of possibilities. Completing user stories often led co-researchers to generate ideas that simply rephrased previous concerns or suggested obvious 'fixes' for current problems, rather than to explore new possibilities and reframe problems. For example, one user story replicated discussions of anti-social behaviour from the second workshop in response to journey recordings, and offers an obvious 'fix':

As a commuter, I would like the Metrocars to have a Metro staff member in every train to provide basic information and security because this will help prevent antisocial behaviour and help with breakdowns with IT, and be another source of information. (User story)

We introduced a set of speculative design proposals in the fourth design workshop that were more successful in encouraging co-researchers to explore a broader design space. We developed these design proposals in response to concerns and ideas previously discussed by co-researchers, and also expressing relevant socio-technical possibilities that might be novel to co-researchers. These speculative design proposals were illustrated on *JigsAudio* pieces and, during the design workshop, co-researchers discussed those of interest to them and recorded their responses using the *JigsAudio* audio recording device. This tactic had mixed success. Between zero and eight responses were given on each idea piece, whilst 17 responses were made on a blank piece used as a 'catch-all.' Nevertheless, co-researchers did explore the broader design space suggested by the speculative design proposals through discussing the implications of such ideas if they were to be implemented. For example, one proposal addressed anti-social behaviour by suggesting crowd-sourced monitoring and display of on-train security camera (CCTV) recordings, which prompted discussions of current technology's shortcomings and of how it might be appropriated for other ends:

You will get those numptys [foolish people] out there that enjoy being centre of attention, then actually it could become a fame game 'I'm going on Metro because I know that I will be videoed' (Workshop *JigsAudio* recording)

And, a design proposal about automatic doors and an extending train to platform ramp to improve accessibility created discussion of the idea's practicality and reliability:

I think the idea of a platform coming out onto the platform from the train for disabled people is superficially a good idea, but that it poses a safety risk

for children and to some disabled people. And is also something that could break down and delay trains. (Workshop *JigsAudio* recording)

Scaling-Up the Design Conversation

As our project progressed, we needed to explore how the experience-centred and exploratory design qualities of the co-researcher activities could be translated to larger scales. The Pop-up Labs and the website did enable us to involve more people in the project: we estimated that 300 public participants talked to us at Pop-up Labs and contributed 425 ratings and 96 comments; and, from November 2016 to June 2017, the website received 3550 visitors who contributed 187 votes and 79 comments. These numbers compare favourably with the other two strands of *Metro Futures*, which reported engaging with 1500 people (Nexus) and 1000 people (Transport Focus). However, we also needed to ensure that the co-researchers' findings seeded further conversations with a larger public group region-wide.

Our intention had always been to share the co-researchers' findings on the website, where visitors could agree, disagree, and leave comments upon co-researchers' recordings and ideas. However, co-researcher findings were not ready at early Pop-up Labs, and visitors' comments at early Pop-up Labs often bore a strong resemblance to the concerns raised by co-researchers. Whilst such comments could usefully reinforce the relevance of co-researchers' findings, there was a missed opportunity for Pop-up Lab visitors to extend and refine this conversation. Furthermore, whilst recordings and ideas could be searched and viewed as lists or on a Metro map on the project website, unless website visitors were prepared to spend time exploring an increasing volume of material, it was becoming increasingly difficult to provide an overview of the co-researchers' findings.

To make the variety and depth of our conversation with co-researchers available and more accessible on the website and at later Pop-up Labs we synthesised lists of the main concerns and ideas as high-level ways in to conversations. We created a set of nine significant concerns (positive and negative) about the current Metro trains based on the co-researchers' keywording and rating activities described above, and the emphasis co-researchers placed on concerns in workshop discussions. We also created a set of nine design proposals based on the user stories co-researchers generated and emphasised in the third workshop. These two sets of nine 'headlines' (as we came to call them) were discussed and refined with co-researchers at the fourth workshop.

We created videos illustrating the two sets of nine headlines, using the co-researchers' recordings, and shared them at later Pop-up Labs and on the website to stimulate discussion at scale. These headline videos were shared at Pop-up Labs on tablet computers using the *ThoughtCloud* app. At the last four Pop-up Labs, visitors could watch the headlines videos on two separate tablet computers, rate them (agree/disagree), and optionally leave audio or video comments explaining their decision. Headlines also became the first visible items

at the top of the concerns and proposals sections of the project website with each headline page accepting visitors' agree/disagree ratings and comments, and linking deeper to the several recordings and ideas it synthesised. Once the Pop-up Labs had ended, *ThoughtCloud* agree/disagree ratings and comments were integrated with those on the website.

The headline videos encouraged Pop-up Lab and website visitors to respond to the co-researchers' findings. In doing so, we hoped that visitors would add nuance and depth to the conversation via elaboration and critique of the co-researchers' findings. The integrated headline comments on the website demonstrate that visitors continued discussing the co-researchers' concerns and ideas rather than simply ratifying them. For example, 20 people agreed and 2 disagreed that seating should be provided alongside pushchair ('buggy') or wheelchair spaces to allow passengers to accompany the child or wheelchair user. Visitors' comments provide further experiences and express some difference of opinion:

...if you've got a child with you as well as a buggy, they're easily at the doors. So, they've got to be away from the doors, but there's got to be enough room for the person who's pushing the wheelchair or buggy to sit beside them. (Pop-up Lab *ThoughtCloud* comment)

Buggies should be folded down. The amount of times buggies sit empty while mothers sit with children on the seat with them is unbelievable. (Pop-up Lab *ThoughtCloud* comment)

METRO FUTURES: THE VALUE OF DESIGN FINDINGS

Nexus published a summary report based on all three strands of *Metro Futures* in August 2017 [25], including findings from our experience-centred co-design activities that we had communicated via a summary report, the project website, and presentations at subsequent events with Nexus (we subsequently provided a further detailed report and video report that informed Nexus' procurement process).

The findings from our experience-centred co-design activities corresponded to several of the passenger concerns and requirements for new Metro trains from the Nexus and Transport Focus strands. Whilst providing Nexus with useful triangulation, our findings also differed from and extended the Nexus and Transport Focus findings in valuable ways.

Adding Value to Common Findings

In several areas our outputs went beyond confirming the main public priorities for the new Metro trains and added experiential detail to concerns, and explored design proposals for tackling these concerns.

All three *Metro Futures* strands reported a need to deal with crowded trains yet our findings added further experiential detail. The Nexus and Transport Focus findings covered common aspects such as crowding around the middle doorways and lack of standing spaces at busy periods. Our co-researchers recorded and discussed crowded trains at

busy travel times but also recorded and discussed the travel experiences that such crowding causes - a recording titled “claustrophobic space,” a comment on existing seating “there’s often no legroom as well as people feeling a bit awkward sitting next to or opposite a stranger,” and recordings of packed and empty trains according to the time of day and location. Co-researchers also explored ways in which crowding on trains could be alleviated including single carriage/corridor trains, a one-way system for getting on and off trains, and electronic ‘busy sensors’ to measure and display the amount of crowding on trains. A speculative design proposal on ‘busy sensors’ generated enthusiasm and discussion amongst the co-researchers, including its practical implementation:

Lights around the doors... Green if it’s quiet, amber for fairly busy... you might get a seat but its limited. You might get everybody looking for green doors...
(Workshop *JigsAudio* comment)

Similarly, beyond agreeing that the design of new trains should consider better information provision and reducing anti-social behaviour, our outputs represented experience-centred design proposals for how this could be achieved. Co-researchers shared uncomfortable experiences of travelling alone and late at night, and explored how visible Metro staff and CCTV might alleviate their concerns (as discussed, earlier). Co-researchers further explored the placement and content of electronic displays and audio announcements including: imagining train windows as displays; information delivered to personal mobile devices; information on connecting trains, buses, and flights; and, clearer or automated driver announcements.

Maintaining Multiple Valuable Perspectives

In most cases, Nexus’ summary report emphasises consensus in participants’ requirements for new trains. Our outputs, however, maintained diverse perspectives as far as possible.

The difference between our and Nexus’ reporting was more than simply noting that more than one option was preferred. Through retaining participants’ descriptions of *why* particular options were preferred in our report and website (through video recordings, comments, and workshop quotes), each option was presented as a potential source of design innovation. This could enable new design proposals to be generated, drawing on and responding to participants’ rationales, rather than ‘averaging out’ their preferences.

For example, the Nexus and Transport Focus findings emphasise linear seating as participants’ preferred solution. Whereas our findings emphasised how participants valued seating layouts differently according to different journey scenarios (e.g. more standing space for short journeys at busy times, greater comfort and storage for longer journeys), and how participants explored flexible seating layouts.

Additional and ‘Off Topic’ Findings

Our findings included discussion of train features that Nexus did not specify in their topics of interest but that nevertheless

represented useful insights. These included: green and sustainable features; the resilience and reliability of trains; on-board ticketing; buttons on doors and sensor-operated doors; and, features that make journeys enjoyable (e.g. large windows, a front seat view, on-board entertainment).

Conversations in our strand also included topics that Nexus stated should not be part of the public consultation but that our co-researchers and other participants nevertheless discussed. In some cases, these ‘off-topic’ conversations could still produce valuable insights. For example, Nexus had stated that the public consultation should exclude Metro stations. Co-researchers raised safety and access concerns about the train to platform gap. This problem is often perceived as requiring modification to stations, but co-researchers also explored train-based ways of addressing this problem, such as extending ramps. Here, allocating train-platform gap problems as a matter of station design would have closed off the opportunity to explore solutions outside this scope. Similarly, Nexus had also stated integration with bus services was not within scope, yet co-researchers discussed on-train information services to support passengers connecting with bus services.

DISCUSSION

Metro Futures, overall, was successful. The three strands of activities enabled Nexus to secure UK Government funding for new Metro trains and ensured that Metro passengers’ concerns and requirements will be addressed in the procurement of a new train fleet. Nexus have been pleased to note attention to the *Metro Futures* findings in proposals received from the train manufacturers bidding for this work. However, how effective was our strand of *Metro Futures* in terms of our commitments to experience-centred co-design at scale? And, given that Nexus are keen to involve our research group and our co-researchers further once a train manufacturer has been chosen, how can attention to passenger experience and the involvement of passengers as co-designers be maintained in subsequent stages?

Focussing on Experience at Scale

A focus on experience was evident in our co-researcher activities and, to a lesser degree, in public interactions at Pop-up Labs and on the project website. Co-researchers’ shared and made sense of their own and each other’s journey experiences, whereas Pop-up Lab and website visitors were once removed from these experiences. Nevertheless, video recordings evoked these experiences and encouraged more personal and empathic engagements with co-researchers’ concerns relating to new Metro trains.

As our account of our strand of *Metro Futures* shows, digital media and technology enabled the experiential focus begun in co-researcher activities to be translated to region-wide conversations. Using digital media technology to record and share relevant experience was effective. Recording on a personal device in response to a set of open prompts, using *Bootlegger* or other means, worked well. And *ThoughtCloud*

and the project website enabled this digital media to be viewed, and voted and commented upon at scale.

Collaborative Exploration of Design Alternatives at Scale

Collaborative generation and exploration of ideas and alternative possibilities featured in the co-researcher and schools activities. Again, this was present in Pop-up Lab and website interactions to a lesser degree. Although Pop-up Lab visitors contributed some ideas via *JigsAudio*, much of the larger scale interaction was with the co-researchers' and school children's ideas. Nevertheless, at both co-researcher and broader public scales, participants explored implications of design ideas presented in addition to stating preferences.

ThoughtCloud and the project website again demonstrated a role for digital media and technology in making smaller scale design conversations accessible at larger scales. And provided a means for both encouraging and supporting larger scale participation.

Supporting Experience-centred Co-Design at Scale

The challenges to scaling-up experience-centred co-design in *Metro Futures* were the risks of diluting or abstracting participants' experiences, and of ongoing design work becoming focussed on static requirements. We are now considering how these challenges might be addressed as the project of replacing the Metro train fleet moves on to its next stage of working with Nexus' chosen train manufacturer.

Dalsgaard highlights establishing participation as a relevant activity for organisational stakeholders in large-scale projects [10]. How, then, might focussing on experience and exploring design proposals with public participants become relevant activities for organisations such as Nexus? We offer two answers from our lessons learned in *Metro Futures*.

Keeping Participants' Experiences and Ideas Alive

We emphasised participants' experiences and ideas in reporting of our strand of *Metro Futures*, and we also ensured that co-researchers and their contributions were highly visible in a video we produced to explain both the design process and its findings. Findings were presented by our co-researchers in their own words and using their experience recordings in this video, and it was then shared via YouTube and the project website to make it more discoverable and engaging in the public domain [28]. The video was premiered at an invite-only celebration event, where our co-researchers mingled with Nexus staff, civic dignitaries, and industry representatives.

This reporting and the interactions with Nexus were important because, at the time, it was not clear whether our research group or our co-researchers would be involved in the next stage design work with train manufacturers. We needed to ensure that Metro passengers' experiences and ideas remained alive in the ensuing work. Having a video in the public domain, featuring the co-researchers and their experiences and ideas, could keep them alive in ongoing work and, if necessary, provide material to hold Nexus to account.

Design Convergence via Design Synthesis

The next stage of Metro train replacement will involve some consolidation of the public consultation findings. Indeed, all design work involves convergence of some sort to progress (c.f. the Double Diamond model of design processes [6]). However, this raises a question of how multiple perspectives are reconciled in subsequent design work, and of how the generative value of multiple perspectives can be retained.

Nexus' summary report emphasised where the Nexus, Transport Focus, and our research group's findings aligned. The language used throughout the report placed emphasis on consensus (e.g. "the most popular [design option]", "scoring highest"), and the executive summary highlights "common issues". The summary report also lists distinct actions for each heading, the only exception being under a heading "other issues considered" where differing viewpoints are given and the report states that "Nexus will be asking train manufacturers to provide their own thoughts and ideas on how to address [these different viewpoints]."

The approach to convergence in Nexus' report, if carried through to the next stage, risks ignoring some participants' perspectives and/or expecting participants to accept the prevailing view. An alternative approach is to attempt to synthesise multiple perspectives in further design work, to see perspectives as inspiration for ongoing design rather than distinct requirements that must be addressed, i.e. combining *aspects* of different experience-centred concerns and design proposals rather combining *entire* concerns or proposals according to their popularity. Keeping experiences and ideas alive is one way of ensuring they are accessible and available for such design convergence via design synthesis.

CONCLUSION

This paper explored how characteristics of experience-centred co-design can be translated to larger scales. We contribute lessons learned from using such an approach in the *Metro Futures* public consultation, which demonstrate that a focus on experience, and a shift from 'problems' to exploring design proposals can be accomplished in larger-scale public interactions through using digital media and technology to interconnect smaller and larger scale activities. The digital tools used in *Metro Futures* require smoother integration but highlight how such socio-technical resources can keep design participants' experiences and ideas alive in ensuing stages of longer-term design projects as resources for further idea generation and design synthesis.

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